

# Let's Talk Water – The hydrology of volcanoes

By Dr. Mike Strobel

When most people think about volcanoes, they think about large mountains with cinder cones at their tops and smoke bellowing from the peak. They also think about flowing lava and huge masses of ash and rock thrown into the air. I would bet that few people think about hydrology (water) when considering the destruction and dangers associated with active volcanoes, but the reality is that water is a major contributor to the hazards of volcanoes.

First of all, what is a volcano? A volcano is “a vent in the surface of the earth through which magma (molten rock) and associated gases and ash erupt, also, the form or structure (usually conical) that is produced by the ejected material” (from <http://volcano.und.nodak.edu/vwdocs/glossary.html>). As one can imagine, scientists have defined a large number of different types of volcanoes, but we don't need to get into that detail in this article.

One way water plays a part in volcanic activities is through the heating and release of ground water. Most people are familiar with Old Faithful and other geysers at Yellowstone National Park. Yellowstone is what we refer to as a large caldera complex, where a hot spot underlying the earth's crust has resulted in an area of baked rocks and heated ground water. In the case of geysers, ground water is heated to high temperatures by the deep magma, is converted to steam, and then escapes through vents in the ground.

In more traditional volcanic settings, such as the many volcanoes along the Pacific coast, hydrology also plays an important role. Look at any picture of a volcano in the Cascades, such as Mt. Rainier, Mt. St. Helens, or Mt. Shasta, and you typically see a high, snow covered peak. Given that volcanic eruptions occur with extremely high temperatures as molten rock escapes to the surface, one would wonder what happens to all this ice and snow.

In the case of Mt. St. Helens, 13 glaciers on this peak were destroyed by the 1980 eruption. Some of the ice was blown away by the eruption, but much of the ice melted and ran off the mountain as water. Ice within the cone of the volcano added to the steam released during the volcanic activities, as hot magma came in contact with the meltwater.

Interesting is that the glacial ice has quickly returned to Mt. St. Helens following the eruption. By 1982, snow was accumulating on the crater floor and now a new glacier is forming between the lava dome and the south wall of the crater.

Getting back to hazards, one of the most dangerous and damaging components to volcanoes would be lahars. A lahar is a mudflow or debris flow that move down the slopes of a volcano. These flows are concentrations of rock debris that are highly saturated from the meltwater on a volcano and move down slope during volcanic activity. Lahars are often initiated by large landslides, heavy rainfall eroding volcanic deposits,

sudden melting of snow and ice near a volcanic vent, or a breakout of water from glaciers, crater lakes, or lakes dammed by volcanic eruptions. Since 1980, each of these listed processes has resulted in lahars at Mt. St. Helens (<http://vulcan.wr.usgs.gov>).

How dangerous are these lahars? One debris flow in Ecuador in 1877 traveled more than 197 miles down one valley at an average speed of about 17 miles per hour. Other debris flows have been estimated to travel as fast as 52 miles per hour in some places. Plus, some debris flows have filled valleys up to 62 feet or more (Miller, 1989, Potential hazards from future volcanic eruptions in California: USGS Bulletin 1847). So, one can see why lahars are considered so dangerous.

Another danger associated with the hydrology of volcanoes is referred to as a jökulhlaup. In common terms, this means a glacial-outburst flood. This is the sudden release of water stored at the base of a glacier. Often, this flood water can pick up sediment and debris and become a lahar.

There are numerous examples of major damage caused by these glacial-outburst floods. At Mt. Hood, jökulhlaups have destroyed numerous roads, trails and bridges over the past century. At Mt. Rainier, huge outburst floods have occurred numerous times and often were triggered by rock avalanches. In general, most of the major volcanoes in the Cascades have experienced various lahars and jökulhlaups over the recent past.

Mt. St. Helens has been in the news a lot lately because of its recent activity. The eruption in 1980 resulted in significant destruction. Much of the damage was related to hydrology. Mudflows following the eruption occurred in many of the river valleys, but the most destructive mudflows were in the Toutle River basin, where more than 65 million cubic yards of sediment was transported. Because of this, the capacity of the Cowlitz River was reduced by 85 percent and the depth of Columbia River navigational channel was decreased from 39 feet to less than 13 feet (<http://vulcan.wr.usgs.gov>). Mudflows also occurred in the Swift Creek, Pine Creek, and Muddy River drainages. Mudflows moved up valley walls as much as 360 feet in some areas and over hills in excess of 250 feet high.

So, we see that volcanoes can be extremely dangerous due to the relation of volcanic activity and hydrology, whether in the form of glaciers or saturated sediments. It shows that it often is not the dramatic aspects of an event, such as a volcanic eruption, that make it so dangerous, but often the associated events such as mudslides and floods.

Next week, I will discuss the Sustainability workshop that took place in Las Vegas this week and some of the key issues addressed. It was very informative and there are many important topics to discuss. If you have questions about volcanoes or any other water issue, write to me in care of the Ely Times or email at [mstrobel@usgs.gov](mailto:mstrobel@usgs.gov).